

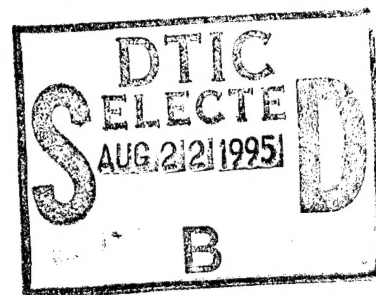
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AN ANALYSIS OF SHIPBOARD CASUALTY INCIDENCE DURING NAVAL COMBAT OPERATIONS

C. G. Blood

R. T. Jolly

M. S. Odowick



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Report No. 95-13

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NAVAL HEALTH RESEARCH CENTER
P. O. BOX 85122
SAN DIEGO, CALIFORNIA 92186 - 5122

NAVAL MEDICAL RESEARCH AND DEVELOPMENT COMMAND
BETHESDA, MARYLAND



**AN ANALYSIS OF SHIPBOARD CASUALTY INCIDENCE
DURING NAVAL COMBAT OPERATIONS**

Christopher G. Blood
Richard T. Jolly, M.D.*
Michael S. Odowick**

Operations Research Division
Medical Information Systems and Operations Research Department
Naval Health Research Center
P.O. Box 85122
San Diego, CA 92186-5122

*Headquarters, Royal Marines
Portsmouth, Hampshire U.K.

**GEO Centers, Inc.

NHRC Report No. 95-13, supported by the Naval Medical Research and Development Command, Department of the Navy, under Work Unit No. M0095.005-6503. The views expressed in this article do not reflect the official policy or position of the Department of Defense, the U.S. Government, nor the U.K. Government.

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EXECUTIVE SUMMARY

Problem

Medical and manpower resource planning for shipboard operations requires projections of the anticipated casualties likely to be incurred during various naval combat scenarios.

Objective

The present investigation seeks to determine the rate that United States and United Kingdom naval vessels were hit by enemy weapons and the rate of injuries among the shipboard crews during various combat operations. A further goal of this investigation is to determine the casualty frequencies associated with specific weapon strikes.

Approach

Ship hit rates per 100 ship days and daily casualty incidence per 1000 strength were computed for U.S. World War II operations, United Kingdom WWII convoy operations, U.S. Korea operations, and for U.K. forces during the Falklands War. Additionally, wounded-in-action and killed-in-action frequencies on individual ships were computed for the above operations.

Results

Ship hit rates were highest during landing operations and during convoy operations. Casualty rates varied greatly during WWII operations but the overall wounded and killed rates for U.S. Pacific operations were very similar to the U.K. experience in the Falklands. Mean casualties likewise varied greatly by type of weapon, with torpedos inflicting the most wounded and killed.

Conclusions

Medical planning for all possible naval contingencies is essential to the effective treatment/evacuation of the shipboard casualties that may be sustained. Data from previous naval engagements indicate that ships are at greatest risk of a hit during littoral operations. Further, numerous incidents occurring both within and outside specific combat operations underscore the devastating consequences in terms of wounded and killed that may be exacted by a single hit. While U.S. air, surface, and sub-surface superiority is widely recognized, casualties sustained during an isolated bomb, missile, or torpedo attack, though manageable, might severely tax the medical capabilities of a deployed task force.

AN ANALYSIS OF SHIPBOARD CASUALTY INCIDENCE DURING NAVAL COMBAT OPERATIONS

Medical resource planning for military operations requires estimates of the casualties likely to be sustained by both shipboard forces and ground troops. These casualty projections are required input to models^{1,2} which forecast the beds, medical equipment, supplies, and health care personnel needed to support the operation. Though much of the previous work in casualty forecasting has focused on projections among land forces,^{3,4,5} it is equally important that medical planners prepare for casualties that may occur among forces afloat. Given that shipboard casualties may require transfer to medical facilities farther away and across a more environmentally hostile topography than that required for land-based casualties, evacuation and treatment conceivably poses greater logistical problems for maritime forces than their ground-based counterparts.

Projections of casualties among forces afloat require two very separate sets of forecasts. First, estimates must be made of the likely numbers of ships that will sustain hits by enemy forces. Second, after determination of the numbers of ships likely to be attacked, the incidence of casualties aboard the individual ships must be projected. The numbers of ships hit during a naval combat scenario, as well as the casualties incurred during specific ship strikes, result from a complex set of dynamics which include shipboard defenses, combat tactics, weapons possessed by the adversary, crew readiness, ship structural design, and human performance.

While the United States is generally recognized to have air, surface, and sub-surface superiority over its potential adversaries, the present-day sophistication and widespread dissemination of anti-ship weaponry places U.S. vessels at some risk in any naval combat operation. Though U.S. air defenses greatly reduce the risk of a successful attack on a naval vessel, that risk may be heightened under certain conditions such as during littoral operations in which an adversary may have the advantages of surprise, cover, and coastal defenses.

In a step toward forecasting casualties that might be sustained in future operations, the present investigation examines the overall casualty rates sustained during previous naval combat operations. Additionally, the current investigation seeks to determine the incidence of successful strikes on naval vessels during afloat operations, as well as the casualties incurred with specific weapon strikes. The operations examined in this study include 1) U.S. forces during World War II, 2) United Kingdom (U.K.) forces escorting convoys

during World War II, 3) U.S forces during the Korean Conflict, and 4) U.K. forces during the Falklands War (OPERATION CORPORATE). Examination of the numbers of wounded and killed in prior maritime engagements may provide a basis for casualty projections of future naval combat scenarios.

METHOD

U.S.: World War II

Archived at the Operational Archives Division of the Navy Historical Center in Washington D.C. is a listing of all afloat combat operations/engagements, a record of the ships involved in each operation and the dates of each ship's involvement. Data on specific naval warfare incidents were obtained from The Summary of War Damage⁶ and the Naval Chronology, World War II⁷. Combining the incident data with the records and dates of the ships participating in various operations allowed the computation of *ship hit rates per 100 ship days* (calculated as: (the number of ships struck/number of ships participating)*100).

Casualty rates were computed using the Bureau of Personnel casualty lists also kept at the Navy Historical Center. Each casualty, listed as WIA (wounded-in-action), or KIA (killed-in-action) is accompanied by data specifying the ship to which that individual was attached, the operation or engagement in which the vessel was involved at the time of the casualty, and the date of the casualty incident. To determine ship populations, the crew complement aboard each vessel was collected from the Navy muster rolls housed at the National Archives; when the crew size was not available at the archives, it was determined from the Dictionary of American Naval Fighting Ships⁸. Casualty incidence was computed as *rates of casualties per 1000 strength per day*.

Additionally, casualty frequencies from specific weapon strikes were obtained from the Medical Officer Reports and After Action Reports maintained at the Navy Historical Center, and from Deck Logs housed at the National Archives. Mean numbers of wounded and killed were computed by weapon and type of ship for attacks on 513 major combatant ships and 355 auxiliary vessels.

U.K.: World War II

While detailed accounts of the total casualties incurred during entire operations were not readily available for United Kingdom convoy operations, historical references^{9,10} were examined to determine the numbers of ships sunk and damaged during various engagements. Ship hit rates were computed per 100 ship days for Royal Navy ships and merchant vessels participating in convoys. Analyses of the attacks sustained during these operations were confined to the periods in which the British forces were engaged by the enemy; computation of

ship hit rates does not include the time periods leading up to the attacks in which travel was unfettered and the risk of attack was relatively minimal.

Specific naval operations examined included: 1) *Operation Pedestal*, a convoy of 14 merchant ships escorted through the Mediterranean Sea by a sixty-four ship force of Royal Navy vessels in August of 1942; 2) two eastbound arctic convoys in July and December, 1942 (*PQ-17* and *JW51B*) in which four and ten Royal Navy ships respectively escorted 34 and 14 merchant vessels; 3) two eastbound convoys (*HX229*, *SC122*), composed of 13 naval vessels and 90 merchant ships, traversing the North Atlantic together in March of 1943; 4) two westbound convoys (*ONS.18*, *ON.202*) which left Liverpool and Milford Haven, U.K. and jointly crossed to North America in September of 1943; and 5) a joint convoy (*SL.139/MKS.30*) traveling from Gibraltar to the U.K. in November of 1943.

Though incomplete data prohibited computation of personnel casualty rates for the above operations, casualty frequencies were available for 104 attacks on U.K. ships¹¹. Mean casualties were computed by weapon and ship type.

U.S.: Korean Conflict

Ship hit rates per 100 ship days were calculated for two major operations during the Korean Conflict: the *China Spring Offensive* (April 22 -- July 8, 1951) and the *China Summer-Fall Offensive* (July 9 -- November 27, 1951). Determination of the ships involved and their respective dates of involvement was made through a listing of all operations and engagements at the Navy Historical Center. A chronology of the U.S. ships attacked was obtained from a historical account of naval operations during the Korean War¹².

U.S. Navy afloat casualty rates per 1000 strength per day were also computed for the two Chinese offensives. The numbers of casualties sustained on the attacked ships were determined from the previously cited historical account¹². Size of crew complements aboard each vessel were determined from the synopses listed in the *Dictionary of American Naval Fighting Ships*⁶. Additionally, mean casualties were computed by weapon and ship type for the ships sunk or damaged across all Korea operations.

U.K.: Falklands War

Ship hit rates per 100 ship days were computed for the United Kingdom (U.K.) naval forces during the Falklands War. Data detailing the numbers of ships hit and the periods of participation of each ship were extracted from administrative records.

Casualty rates per 1000 strength per day were computed for personnel aboard

Royal Navy warships and Royal Fleet auxilliary ships. The numbers of WIA and KIA were extracted from OPERATION CORPORATE medical records maintained during the 1982 conflict. Additionally, mean casualties by weapon and ship type were computed for the ships that were attacked during the Falklands Conflict.

RESULTS

U.S.: World War II

Table 1 is a presentation of the number of hits, total ship days, rate of hits per 100 ship days, and WIA and KIA rates sustained during individual WWII operations among participating surface ships. As can be seen in Table 1, the hit rates varied considerably by operation, ranging from 0.00 to 50.00 hits per 100 ship days. The overall hit rates across Pacific operations and Atlantic operations were 0.32 and 0.20 hits per 100 ship days, respectively. The daily WIA and KIA rates across Pacific operations were 0.30 and 0.26 per 1000 strength, respectively. In the European theater, the WIA and KIA rates were 0.53 and 0.31 per 1000 strength per day.

Table 2 presents the mean casualties sustained aboard major combatants by weapon type. The "multiple weapon" category, which represents strikes by two or more different weapon systems, had the highest average number of both wounded and killed; kamikazes yielded the second highest mean number of WIA while torpedos strikes ranked second in KIA incurred. The mean wounded and killed respectively for each weapon type were: kamikaze - 39.0, 23.3; gunfire - 22.5, 19.0; bomb - 30.3, 33.3; torpedo - 37.3, 78.1; mine - 24.2, 24.0; multiple - 71.5, 135.2. The overall mean WIA and KIA across all weapon types for the 513 attacks on major combatants were 38.8 and 38.1.

Table 3 is a display of the mean WIA and KIA sustained on auxiliary ships by weapon type. The average number of wounded and killed across the 355 attacks were 16.4 and 10.8, respectively. The mean total casualties (WIA and KIA combined) by weapon types were: kamikaze - 26.7; gunfire - 10.8; bomb - 30.9; mine - 27.5; torpedo - 53.9.

U.K.: World War II

Ship hit rates per 100 ship days for *Operation Pedestal* are shown in Table 4 for both naval vessels and the merchant ships that were being escorted. While the Mediterranean Sea segment of this operation was only two days in length, there were 19 hits among the 78 ships in this convoy yielding an overall hit rate of 14.7 hits per 100 ship days. Also presented are the hit rates for two eastbound arctic convoys, one in July of 1942 (PQ-17) and one in December of 1942 (JW51B). The overall rates for these two operations were 12.4 and 4.3 hits per 100 ship days, respectively. Hit rates for two eastbound convoys that crossed

the North Atlantic together (HX229/SC122) in 1943 are also shown in Table 4. While no naval vessels were hit during this operation, the 29 hits on merchant vessels yielded an overall rate of 7.7 hits per 100 ship days. Lastly, Table 4 displays the hit rates for a joint westbound convoy (ONS.18/ON.202) traversing the North Atlantic from the U.K. to North America as well as a joint convoy (SL.139/MKS.30) traveling from Gibraltar to the U.K. The overall hit rates per 100 ship days for these two operations were 1.95 and 0.89, respectively.

Table 5 shows the mean frequencies of WIA and KIA incurred during various attacks on Royal Navy major combatant ships. The mean number of wounded across the 104 shipboard attacks was 13.7 while the average killed-in-action per incident was 36.9. The mean total casualties by weapon types were: bomb - 44.1; gunfire - 63.1; mine - 82.0; torpedo - 90.2.

U.S.: Korean Conflict

Ship hit rates and casualty incidence are presented in Table 6 for U.S. naval operations corresponding to two major Chinese offensives. Of the 15 casualty producing incidents during the two operations, 13 were attacks by shore batteries and two were mine detonations. The number of hits per 100 ship days were 0.13 and 0.09 respectively for the Spring and Summer/Fall offensives while the total casualty rates were 0.045 and 0.02 per 1000 strength per day.

Table 7 displays the mean WIA and KIA incurred aboard all U.S. ships attacked during the Korean War (attacks occurred between September, 1950 and July, 1953). The mean WIA across these 93 incidents was 4.66 while the mean KIA was 1.58.

U.K.: Falklands Conflict

The casualty statistics for the Falklands data are based upon 36 Royal Navy (RN) surface warships and 23 Royal Fleet Auxiliary ships that participated in the conflict. Because the focus of this paper has been on surface ships, submarines have been excluded from these analyses as have the 36 merchant 'ships taken up from trade' (STUFT) for use in OPERATION CORPORATE. (It should be noted that there were several attacks on the merchant ships; casualties were sustained aboard only one of these ships, however.)

Seventeen of the RN warships were attacked, as were six of the Fleet Auxiliary craft. The rate of WIA was 0.32 per 1000 strength per day while the KIA rate was 0.22. During the period of April 30 through June 16 there was a total of 1,723 ship days and 23 attacks, yielding a ship hit rate of 1.34 per 100 ship days.

Of the 23 attacks on Royal Navy warships and auxiliary vessels, sixteen were

bomb attacks, five were cannon fire, and two were air-launched Exocet missiles. The mean WIA across all attacks was 8.26 and the mean KIA was 5.78. Table 8 displays the mean casualties by weapon and ship type for the 23 incidents. The mean WIA for bombs, cannon fire, and missiles were 8.9, 1.8, and 19.0. The average numbers of KIA for the three weapon types were 6.2, 0.0, and 16.5.

DISCUSSION

Medical planning for naval combat operations is essential to ensuring that sufficient medical resources and evacuation assets are allocated to accommodate the casualties that may be sustained^{13,14}. As a preliminary step toward projecting casualties afloat in future operations, the present investigation examined the proportions of all ships in previous combat operations that were attacked and examined the casualties resulting from such attacks.

While the WWII U.K. convoys had the highest ship hit incidence of all the naval operations examined, these rates were based on the time periods in which escort ships and merchant vessels were particularly vulnerable to attacks by German forces, that is, when the distances between the convoys and land were not great; the notion that littoral operations place naval vessels at heightened risk is supported by the fact that the highest hit rates were evidenced among the convoys that were approaching land or which were within constrained waters. Also, though some U.S. amphibious operations in WWII exhibited high ship hit rates, the numerous ships involved and the relative temporal lengths of a number of littoral/landing operations (e.g., Leyte, Okinawa, Iwo Jima) yielded relatively low ship hit rates even though substantial numbers of ship hits took place. The ship hit rate for the Falkland Island Conflict, a relatively brief operation, was comparatively high, again attributable to the apparent heightened risks of littoral operations. Ship hit rates of U.S. coastal forces during the Chinese/Korean offensives were low reflecting the Navy's supporting role rather than outright naval warfare, and because opposition attacks were limited mainly to mines and shore batteries.

Interestingly, the U.K. rates of casualties per 1000 strength in the Falklands operation were very similar to the overall WIA and KIA rates for the U.S. in WWII Pacific operations, suggesting that contemporary changes to ships may have limited impact on the casualty incidence sustained when an adversary is able to penetrate air defenses. Overall afloat casualty rates during Korean operations were low reflecting the paucity of ship strikes.

The mean numbers of casualties sustained in various shipboard attacks are lower when comparing more recent data (Korea, Falklands) with casualty data from

World War II (U.S., U.K.). It needs to be emphasized that the average numbers of casualties seen in the more recent mine and bomb incidents, while lower than those observed in WWII incidents, are based on small numbers of observations which in turn yield greater uncertainty as to their predictive validity.

Because attacks during recent naval combat operations have been few, a number of shipboard incidents occurring between 1965 and 1988, though not parts of well-defined operations, were also examined to determine the casualties sustained. These incidents included five collisions, four explosions, five fires, ten gunfire attacks, four mine explosions, a missile attack, and a multiple attack involving torpedoes, rockets, napalm, and machine gun strafing. Appendix A presents the numbers of WIA and KIA incurred during these incidents. While casualties in some incidents were relatively few, these data indicate that any shipboard incident involving fires and/or explosions has the potential to yield a high number of casualties.

CONCLUSIONS

Data from previous naval engagements indicate that ships are at greatest risk of a hit during littoral operations. Further, numerous incidents occurring both within and outside specific combat operations underscore the devastating consequences in terms of wounded and killed that may be exacted by a single hit. Casualties sustained during an isolated bomb, missile, or torpedo attack, though manageable, might severely tax the medical capabilities of a deployed task force; however, a combination of strikes on an afloat task force would undoubtedly overwhelm the medical capabilities of the deployed force. While U.S. surface, sub-surface, and air superiority over potential adversaries is widely recognized and respected, the formidable undertaking of treating and evacuating seriously wounded personnel from a potentially hostile marine environment likewise needs to be recognized and respected.

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TABLE 1. RATES OF HITS ON U.S. VESSELS DURING WORLD WAR II OPERATIONS

<u>ASIATIC-PACIFIC AREA</u>					
<u>OPERATION</u>	<u>SHIP HITS</u>	<u>TOTAL SHIP DAYS</u>	<u>HIT RATE*</u>	<u>WIA RATE**</u>	<u>KIA RATE**</u>
PHILIPPINE ISLANDS OPERATION	40	4498	0.89	0.44	2.56
NETHERLANDS EAST INDIES					
MAKAMAR STRAIT	1	8	12.50	2.15	0.00
BADOENG STRAIT	0	12	0.00	1.64	0.55
JAVA SEA	0	4	0.00	0.00	0.00
CORAL SEA	6	102	5.88	2.17	8.90
MIDWAY	2	160	1.25	1.81	1.71
GUADALCANAL-TULAGI LANDINGS	14	220	6.36	6.63	11.55
CAPTURE/DEFENSE OF GUADALCANAL	26	2864	0.91	0.48	0.70
EASTERN SOLOMONS	2	57	3.51	2.04	2.04
CAPE ESPERANCE	4	18	22.22	13.82	17.24
SANTA CRUZ ISLANDS	8	24	33.33	18.77	13.51
GUADALCANAL (3d SAVO)	19	141	13.48	8.84	21.34
TASSAFARONGA (4th SAVO)	4	22	18.18	14.06	36.44
RENNEL ISLAND	2	52	3.85	2.25	2.90
CONSOLIDATION SOLOMON ISLANDS					
CONSOLIDATION OF SO. SOLOMONS	8	1114	0.72	0.27	0.12
CONSOLIDATION OF NO. SOLOMONS	4	6342	0.06	0.01	0.00
ALEUTIANS OPERATION					
KOMANDORSKI ISLAND	3	6	50.00	10.20	3.11
ATTU OCCUPATION	0	1047	0.00	0.01	0.01
NEW GEORGIA GROUP OPERATION					
NEW GEORGIA-RENDOVA-VANGUNU	8	2151	0.37	0.62	0.70
KULA GULF ACTION	1	14	7.14	8.99	25.40
KOLOMBANGARA ACTION	3	29	10.34	2.32	5.32
VELLA GULF ACTION	0	12	0.00	0.38	0.00
VELLA LAVELLA OCCUPATION	7	232	3.02	0.75	0.27
ACTION OFF VELLA LAVELLA	2	6	33.33	38.94	65.95
BISMARCK ARCHIPELAGO OPERATION	13	3471	0.37	0.29	0.24
TREASURY-BOUGAINVILLE OPER.	19	2068	0.92	0.53	0.32
GILBERT ISLANDS OPERATION	13	3541	0.37	0.24	0.32
MARSHALL ISLANDS OPERATION	5	4510	0.11	0.08	0.02

*Hit Rates are per 100 ship days.

**Casualty rates are per 1000 strength per day.

TABLE 1--cont. RATES OF HITS ON U.S. VESSELS DURING WORLD WAR II OPERATIONS

<u>ASIATIC-PACIFIC AREA</u>					
<u>OPERATION</u>	<u>SHIP HITS</u>	<u>TOTAL SHIP DAYS</u>	<u>HIT RATE*</u>	<u>WIA RATE**</u>	<u>KIA RATE**</u>
WESTERN NEW GUINEA OPERATION	8	5726	0.14	0.12	0.05
MARIANAS OPERATION	37	25991	0.14	0.08	0.02
WESTERN CAROLINE ISLANDS OPER.	11	22040	0.05	0.02	0.01
LEYTE OPERATION					
LEYTE LANDINGS	65	15493	0.42	0.39	0.17
BATTLE OF SURIGAN STRAIT	2	283	0.71	0.03	0.00
3d FLEET SUPPORTING OKINAWA	0	98	0.00	0.02	0.00
NO. LUZON/FORMOSA ATTACKS	9	404	2.23	0.49	0.20
LUZON ATTACKS	7	1677	0.42	0.26	0.13
VISAYAS ATTACKS	0	53	0.00	0.02	0.00
ORMOC BAY LANDINGS	7	250	2.80	7.97	4.33
BATTLE OF CAPE ENGANO	1	3	33.33	160.08	89.78
LUZON OPERATION					
MINDORO LANDINGS	9	999	0.90	2.27	0.90
LINGAYEN GULF LANDING	62	7037	0.88	1.28	0.42
3d FLEET-LUZON ATTACKS	1	267	0.37	0.06	0.03
FORMOSA ATTACKS	4	658	0.61	0.76	0.44
CHINA COAST ATTACKS	0	256	0.00	0.02	0.01
NANSEL SHOTO ATTACK	0	133	0.00	0.00	0.00
IWO JIMA OPERATION					
ASSAULT OCCUPATION IWO JIMA	52	11141	0.47	0.26	0.15
5TH FLEET RAIDS HONSHU/ NANSEL SHOTO	0	571	0.00	0.00	0.00
BOMBARDMENTS OF IWO JIMA	4	68	5.88	0.23	0.13
OKINAWA GUNTO OPERATION					
ASSAULT/OCCUPATION	254	102237	0.25	0.31	0.18
5TH & 3d FLEET RAIDS	36	15691	0.23	0.14	0.13
KURILE ISLANDS OPERATION	1	169	0.59	0.02	0.00
BORNEO OPERATIONS					
TARAKAN ISLAND OPERATION	6	752	0.80	0.19	0.07
BRUNEI BAY OPERATIONS	1	668	0.15	0.15	0.07
BALIKPAPAN OPERATIONS	14	3303	0.42	0.20	0.02
TINIAN CAPTURE	2	1522	0.13	0.62	0.16
CONSOLIDATION SO. PHILIPPINES	2	4834	0.04	0.15	0.05

*Hit Rates are per 100 ship days.

**Casualty rates are per 1000 strength per day.

TABLE 1--cont. RATES OF HITS ON U.S. VESSELS DURING WORLD WAR II OPERATIONS

<u>EUROPEAN-AFRICAN-MIDDLE EASTERN AREA</u>					
<u>OPERATION</u>	<u>SHIP HITS</u>	<u>TOTAL SHIP DAYS</u>	<u>HIT RATE*</u>	<u>WIA RATE**</u>	<u>KIA RATE**</u>
NORTH AFRICAN OCCUPATION					
ALGERIA-MOROCCO LANDINGS	14	387	3.62	0.83	0.82
ACTIONS OFF CASABLANCA	2	15	13.33	3.30	0.00
TUNISIAN OPERATIONS	4	13574	0.03	0.06	0.02
SICILIAN OCCUPATION	29	4758	0.61	1.14	0.64
SALERNO LANDINGS	15	3771	0.40	0.77	1.41
WEST COAST OF ITALY OP-1944					
ANZIO NETTUNO ADV LANDINGS	13	4748	0.27	0.80	0.54
BOMBARDMENTS FORMIA-ANZIO	0	303	0.00	0.01	0.00
ELBA AND PIANOSA LANDINGS	0	42	0.00	6.45	1.17
INVASION OF NORMANDY	39	15125	0.26	1.11	0.46
INVASION OF SO. FRANCE	10	20950	0.05	0.11	0.02

*Hit Rates are per 100 ship days.

**Casualty rates are per 1000 strength per day.

TABLE 2. MEAN CASUALTIES SUSTAINED ON MAJOR COMBATANTS BY WEAPON; WWII

<u>WEAPON</u>	<u>SHIP TYPE</u>	<u>NO. OF INCIDENTS</u>	<u>MEAN WIA</u>	<u>MEAN KIA</u>
KAMIKAZE	BATTLESHIP (BB)	16	47.7	16.2
	CRUISER (CA)	5	35.2	11.0
	CRUISER (CL)	8	54.6	26.6
	CARRIER (CV)	16	88.6	59.8
	CARRIER (CVE)	17	63.1	36.2
	CARRIER (CVL)	4	42.2	32.2
	DESTROYER (DD)	100	30.4	20.3
	DESTROYER (DE)	24	14.2	6.8
GUNFIRE	BATTLESHIP (BB)	14	30.9	8.4
	CRUISER (CA)	10	48.5	33.2
	CRUISER (CL)	7	9.3	14.6
	CARRIER (CV)	2	21.5	4.0
	CARRIER (CVE)	2	140.0	63.0
	CARRIER (CVL)	1	28.0	7.0
	DESTROYER (DD)	78	15.0	18.6
	DESTROYER (DE)	4	37.8	25.0
BOMB	BATTLESHIP (BB)	4	34.0	13.8
	CRUISER (CA)	4	12.0	18.8
	CRUISER (CL)	11	53.1	44.0
	CARRIER (CV)	13	72.6	76.2
	CARRIER (CVE)	2	11.5	7.0
	CARRIER (CVL)	1	182.0	101.0
	DESTROYER (DD)	46	12.9	22.8
	DESTROYER (DE)	2	1.5	00.0
TORPEDO	BATTLESHIP (BB)	6	26.7	91.8
	CRUISER (CA)	9	67.3	149.6
	CRUISER (CL)	10	29.4	108.1
	CARRIER (CV)	5	50.0	39.4
	CARRIER (CVE)	2	106.0	233.0
	CARRIER (CVL)	1	44.0	17.0
	DESTROYER (DD)	28	24.1	61.2
	DESTROYER (DE)	14	40.0	34.6
MINE	CRUISER (CL)	1	00.0	00.0
	DESTROYER (DD)	15	23.1	24.2
	DESTROYER (DE)	3	44.0	31.3
MULTIPLE	BATTLESHIP (BB)	3	82.0	415.7
	CRUISER (CA)	4	129.8	344.8
	CRUISER (CL)	3	47.7	56.7
	CARRIER (CV)	3	97.7	84.3
	CARRIER (CVE)	3	65.0	28.0
	DESTROYER (DD)	11	51.1	57.6
	DESTROYER (DE)	1	45.0	19.0

TABLE 3. MEAN CASUALTIES SUSTAINED ON AUXILIARY SHIPS BY WEAPON; WWII

<u>WEAPON</u>	<u>SHIP TYPE</u>	<u>NO. OF INCIDENTS</u>	<u>MEAN WIA</u>	<u>MEAN KIA</u>
KAMIKAZE	MINE CRAFT	45	14.6	7.8
	TANK LANDING	16	12.5	5.6
	TRANSPORT	36	29.2	11.2
	MOTOR TORPEDO	2	7.5	4.0
	SUB CHASER	4	11.8	3.0
	CARGO	5	8.8	1.2
	OILER	2	8.5	1.0
	TENDER	5	20.6	13.8
GUNFIRE	TUG	2	18.5	4.0
	MINE CRAFT	14	4.9	3.2
	TANK LANDING	33	5.9	0.7
	TRANSPORT	7	15.7	12.7
	MOTOR TORPEDO	11	1.6	4.6
	SUB CHASER	2	6.0	2.5
	CARGO	3	1.0	0.0
	TENDER	1	0.0	0.0
BOMB	TUG	2	4.0	0.5
	MINE CRAFT	15	8.7	4.1
	TANK LANDING	17	16.6	6.3
	TRANSPORT	13	13.9	15.2
	MOTOR TORPEDO	6	5.0	5.7
	SUB CHASER	3	20.3	9.7
	CARGO	3	10.0	5.7
	OILER	7	20.3	54.1
MINE	TENDER	5	24.6	68.6
	TUG	1	49.0	18.0
	MINE CRAFT	35	15.7	5.7
	TANK LANDING	7	51.3	12.4
	TRANSPORT	1	53.0	0.0
	MOTOR TORPEDO	3	6.3	0.0
	SUB CHASER	3	7.3	6.7
	TENDER	1	62.0	16.0
TORPEDO	TUG	1	10.0	7.0
	MINE CRAFT	3	57.3	39.3
	TANK LANDING	16	29.1	37.6
	TRANSPORT	10	18.2	22.2
	SUB CHASER	1	8.0	29.0
	CARGO	7	22.4	4.3
	OILER	5	22.8	23.8
	TUG	2	23.5	25.5

TABLE 4. SHIP HIT RATES DURING WWII ROYAL NAVY CONVOY OPERATIONS

	<u>TOTAL SHIPS</u>	<u>SHIP DAYS</u>	<u>HITS</u>	<u>HIT RATE*</u>
OPERATION PEDESTAL (AUG 11-13, 1942)				
NAVAL SHIPS	64	103	9	8.74
MERCHANT SHIPS	14	26	10	38.46
CONVOY PQ-17 (JULY 4-10, 1942)				
NAVAL SHIPS	4	28	0	0.00
MERCHANT SHIPS	34	158	23	14.56
CONVOY JW51B (DEC 29-31, 1942)				
NAVAL SHIPS	10	28	3	10.71
MERCHANT SHIPS	14	42	0	0.00
CONVOY HX229/SC122 (MAR 16-19, 1943)				
NAVAL SHIPS	13	52	0	0.00
MERCHANT SHIPS	90	326	29	8.90
CONVOY ONS.18/ON.202 (SEPT 18-23, 1943)				
NAVAL SHIPS	20	112	4	3.57
MERCHANT SHIPS	67	402	6	1.49
CONVOY SL.139/MKS.30 (NOV 18-21, 1943)				
NAVAL SHIPS	19	73	1	1.37
MERCHANT SHIPS	66	264	2	0.76

*Hit rates are per 100 ship days and represent time periods in which convoys were at greatest risk.

TABLE 5. MEAN CASUALTIES SUSTAINED BY WEAPON AND SHIP TYPE
AMONG U.K. FORCES DURING WORLD WAR II

<u>WEAPON</u>	<u>SHIP TYPE</u>	<u>NUMBER OF INCIDENTS</u>	<u>MEAN WIA</u>	<u>MEAN KIA</u>
BOMB	BATTLESHIP	7	15.4	7.4
	CRUISER	23	22.5	41.9
	CARRIER	4	44.8	41.2
	DESTROYER	47	9.3	24.6
GUNFIRE	BATTLESHIP	2	2.5	0.5
	CARRIER	1	34.0	204.0
	DESTROYER	11	5.8	52.3
MINE	DESTROYER	1	23.0	59.0
TORPEDO	CRUISER	2	1.5	6.0
	CARRIER	1	0.0	507.0
	DESTROYER	5	10.2	29.8

**TABLE 6. SHIP HIT RATES AND CASUALTY INCIDENCE SUSTAINED BY U.S.
FORCES AFLOAT DURING CHINESE OFFENSIVES OF THE KOREAN WAR**

	<u>SPRING OFFENSIVE</u> (Apr. 22-Jul. 8, 1951)	<u>SUMMER-FALL OFFENSIVE</u> (Jul. 9-Nov. 27, 1951)
NUMBER OF HITS	7	8
NUMBER OF SHIPDAYS	5278	8755
HITS/100 SHIPDAYS	0.13	0.09
NUMBER OF WIA	63	43
NUMBER OF KIA	32	11
NUMBER OF MANDAYS	2,116,424	2,720,822
WIA RATE*	0.03	0.02
KIA RATE*	0.02	0.00

*Rates are per 1000 strength per day

TABLE 7. CASUALTIES SUSTAINED ON U.S. SHIPS DURING KOREAN CONFLICT

	<u>SHORE BATTERY</u>			<u>MINE</u>		
	<u>NO. OF INCIDENTS</u>	<u>MEAN WIA</u>	<u>MEAN KIA</u>	<u>NO. OF INCIDENTS</u>	<u>MEAN WIA</u>	<u>MEAN KIA</u>
MINESWEEPER (AM)	6	1.0	0.3	2	39.5	6.5
MOTOR MINESWEEPER (AMS)	7	0.8	0.2	2	9.0	15.5
SALVAGE SHIP (ARS)	1	0.0	0.0			
FLEET OCEAN TUG (ATF)				1	5.0	15.5
BATTLESHIP (BB)	2	2.6	0.9			
HEAVY CRUISER (CA)	6	3.2	6.2			
LIGHT CRUISER (CL)	1	0.0	0.0			
DESTROYER (DD)	40	2.9	0.5	4	26.0	11.0
ANTISUBMARINE DESTROYER (DDE)	1	6.8	0.2			
RADAR PICKET DESTROYER (DDR)	3	5.7	0.3	1	18.0	9.0
DESTROYER ESCORT (DE)	3	0.6	2.4			
DESTROYER MINESWEEPER (DMS)	6	2.3	1.2			
DOCK LANDING SHIP (LSD)	2	1.5	0.8			
LANDING SHIP (ROCKET) (LSMR)	1	3.8	0.2			
TANK LANDING SHIP (LST)	1	0.0	0.0			
PATROL ESCORT (PF)	3	6.2	0.8			

**TABLE 8. MEAN CASUALTIES SUSTAINED BY WEAPON AND SHIP TYPE
AMONG U.K. FORCES DURING THE FALKLANDS CONFLICT**

<u>WEAPON</u>	<u>SHIP TYPE</u>	<u>NUMBER OF INCIDENTS</u>	<u>MEAN WIA</u>	<u>MEAN KIA</u>
BOMB	DESTROYER	2	11.0	9.5
	FRIGATE	6	8.8	4.3
	LANDING SHIP	6	10.2	9.2
	LIGHT CRUISER	2	3.5	0.0
CANNON	FRIGATE	3	3.0	0.0
	LANDING SHIP	2	0.0	0.0
EXOCET (ALCM)	DESTROYER	1	24.0	20.0
	LIGHT CRUISER	1	14.0	13.0

APPENDIX A. CASUALTIES SUSTAINED DURING INDIVIDUAL SHIPBOARD INCIDENTS; 1965-1988

<u>SHIP TYPE</u>	<u>CAUSE</u>	<u>WIA</u>	<u>KIA</u>	<u>YEAR</u>
CARRIER (CVA)	COLLISION	0	0	65
CARRIER (CVS)	COLLISION	0	0	68
DESTROYER (DD)	COLLISION	1	1	65
DESTROYER (DD)	COLLISION	0	0	68
CRUISER (CG)	COLLISION	46	7	75
DESTROYER (DD)	EXPLOSION	3	3	65
DESTROYER (DD)	EXPLOSION	3	0	66
DESTROYER (DD)	EXPLOSION	6	0	67
CRUISER (CA)	EXPLOSION	36	20	72
CARRIER (CVA)	FIRE	28	2	65
CARRIER (CVA)	FIRE	0	44	66
CARRIER (CVA)	FIRE	60	132	67
CARRIER (CVAN)	FIRE	65	27	68
CARRIER (CVS)	FIRE	2	3	67
CRUISER (CA)	GUNFIRE	0	0	67
DESTROYER (DD)	GUNFIRE	0	0	66
DESTROYER (DD)	GUNFIRE	4	2	66
DESTROYER (DD)	GUNFIRE	6	0	67
DESTROYER (DD)	GUNFIRE	9	1	67
DESTROYER (DD)	GUNFIRE	2	1	67
DESTROYER (DD)	GUNFIRE	1	0	68
DESTROYER (DD)	GUNFIRE	0	0	68
TANK LANDING SHIP (LST)	GUNFIRE	9	1	67
TANK LANDING SHIP (LST)	GUNFIRE	25	2	68
TANK LANDING SHIP (LST)	MINE	27	17	68
MINESWEEPER (MSB)	MINE	0	0	66
MINESWEEPER (MSB)	MINE	4	2	66
FRIGATE (FFG)	MINE	10	0	88
FRIGATE (FFG)	MISSILE	17	35	87
RESEARCH SHIP (AGTR)	MULTIPLE ATTACKS	167	34	67

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE 16 Mar 95		3. REPORT TYPE AND DATE COVERED Interim Oct 94 - March 95
4. TITLE AND SUBTITLE An Analysis of Shipboard Casualty Incidence During Naval COMbat Operations			5. FUNDING NUMBERS Program Element: 63706N Work Unit Number: M0095.005-6503	
6. AUTHOR(S) Christopher G. Blood Michael S. Odowick Richard T. Jolly				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Health Research Center P. O. Box 85122 San Diego, CA 92186-5122			8. PERFORMING ORGANIZATION Report No. 95-13	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Naval Medical Research and Development Command National Naval Medical Center Building 1, Tower 2 Bethesda, MD 20889-5044			10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) Ship attack rates and shipboard casualty incidence were examined for naval operations from four conflicts: United States (U.S.) forces in World War II, United Kingdom (U.K.) forces in World War II, U.S. forces in the Korean Conflict, and U.K. forces in the Falklands Conflict. The hit rate on U.K. warships for the convoys examined was 4.29 per 100 ship-days; the hit rate on the merchant vessels being escorted was 5.75. The hit rates for two major Chinese offensives during the Korean Conflict were 0.13 and 0.09. The ship hit rate during the Falklands Conflict was 1.34 per 100 ship-days. The wounded-in-action rates during WWII Pacific operations, WWII Atlantic operations, and the Falklands Conflict was 0.30, 0.53, and 0.32 per 100 strength per day respectively. The Killed-in-action rates were 0.26, 0.31, and 0.22 per 1000 strength respectively. The mean WIA on U.S. warships during WWII was 38.1 per attack while the mean WIA on U.S. auxiliary ships was 16.4 per attack incident; the mean WIA across warships and auxiliary vessels combined during the Falklands Conflict was 8.3.				
14. SUBJECT TERMS shipboard casualties ship hit rates Falklands Conflict wounded-in-action World War II killed-in-action Korea			15. NUMBER OF PAGES 23	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT Unlimited	